INTERNSHIP PROPOSAL

(One page maximum)

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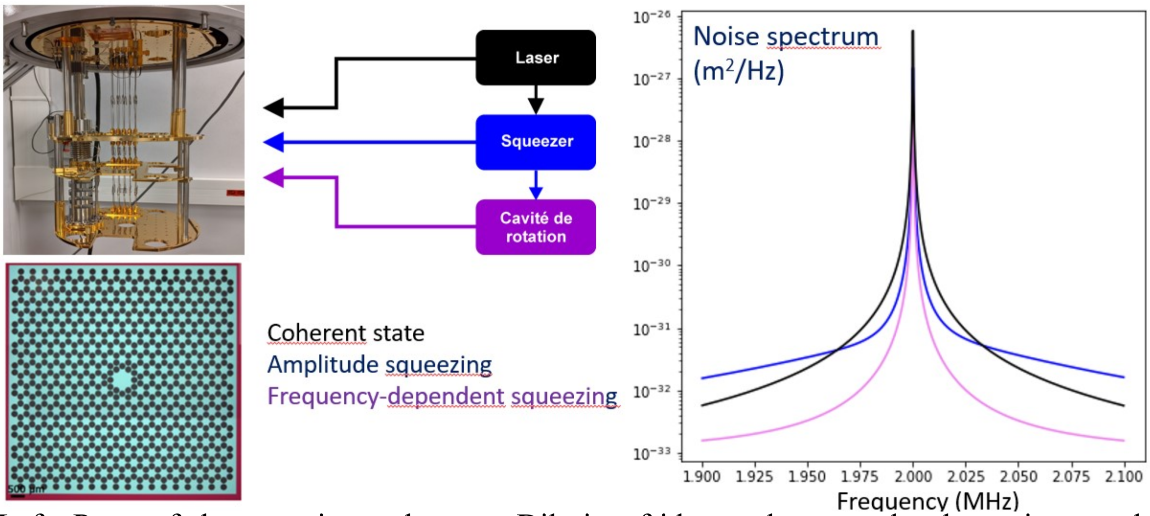
Thesis possibility after internship: YES
Funding: YES (doctoral fellowship or ANR)

Optomechanical measurements beyond the Standard Quantum Limit

Sensing of mechanical motion is routinely performed by optical interferometry, with some state-of-the-art experiments (for instance, gravitational-wave detection) mostly limited by quantum fluctuations of the laser field. Quantum noise leads to the Standard Quantum Limit (SQL), the smallest possible displacement one can probe with coherent laser light.

Quantum noise and the SQL can however be beaten using quantum squeezed states of light. The goal of this project is to experimentally demonstrate broadband measurements below the SQL with a nanomechanical membrane resonator, using a combination of state-of-the-art subsystems: a frequency-dependent squeezed light source (Optical Parametric Oscillator and rotation cavity), a high-Q optomechanical membrane resonator in the MHz range, and a high-finesse fiber cavity inside a dry dilution fridge. This project is in collaboration with several groups inside the Virgo Collaboration, the Quantum Optics group at Australian National University and the Atom Chip group at LKB.

Keywords: microfabrication, quantum-limited laser sources, nonlinear optics, low-noise electronics, digital feedback loops, dilution cryogenics…



Left: Parts of the experimental setup. Dilution fridge and mm-scale phononic-crystal SiN nanomembrane. Center: different stages to demonstrate and go beyond quantum limits? Right: Expected noise spectra for realistic parameters. Black curve corresponds to coherent laser light. Blue curve corresponds to amplitude squeezing, as obtained with an OPO: radiation-pressure noise is lowered close to the resonance frequency, at the expense of additional phase squeezing (at the side of the spectrum). Magenta curve corresponds to frequency-dependent squeezing: sensitivity is increased on the whole frequency band.

Condensed Matter Physics: **YES** Soft Matter and Biological Physics: NO
Quantum Physics: **YES** Theoretical Physics: NO